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BEETLE WINGS

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In most groups of insects our ideas of grouping and our classifications lean heavily on characters of the venation. But in the Coleoptera the wings have been relatively neglected, for several reasons. Firstly the wings don't show on a beetle as customarily mounted; then there are plenty of characters that do show on the outside of these neatly chitinized creatures, so the need to go deeper was not felt strongly. Thirdly they got the reputation of being unduly variable,- which is not true. Then a large proportion of beetles are minute, and like other minute insects tend to lose the wing-veins. The pattern of folding, which does remain in these minute forms, is difficult to work out, and needs a special technique if it is to be done completely, and so has been almost completely left alone, while the one or two published schemes were totally incorrect; thus part of Woodworth's diagrams showed a main fold along the anal furrow, where there is almost never a fold, and the fold is absent in the genera he claims to figure.

Characters of the wing venation are on the whole more useful within families than for major classification, so I will pass over them with a mention. Some idea of the variety of venational types can be gained from the figures in my paper in Ann. Ent. Soc. Am. 15, 328-352, 1922, and especially in Kempers, Ent. Mitt. 12, 71-115, 1923. But a few orienting points are needed to understand the folding. The two main veins of the wing are Radius and Cubitus, and the area between them may be called the "cell", as in the Lepidoptera. It is bounded at its outer end by a variable system of veins and folds, of which the most important are the two that hook back into the cell, - the radial and medial recurrents (Rr and Mr). At the lower outer angle of the cell there is a small cell cut off in the Adephaga and Cupes, the oblong cell. Further out the costa in primitive forms shows the usual thickening, the stigma, and below this are two or more flat, weak and diffuse veins which the Germans call Strahladern.

The patterns on which the wings are folded are of much more importance in classification, and I have described the ways to get at them in Jour. N.Y. Ent. Soc., 34, 42 ff., 1926. But to determine the basic type of folding it is not necessary to work out the folding completely, but mainly to follow along the costal edge and note how it behaves. As one runs out from the base, he will usually find the costa continues undisturbed to well beyond the middle of the wing, when it turns sharply back. This is the pivot or hinge, and is produced by a fold up and a fold down meeting at an angle just below the costal edge. If the concave fold comes first, the outer part of the wing will overlie the basal, and we call the hinge normal. This type lies just beyond the cell, as described above, and before the stigma, when present, and marks the great majority of beetles; even when at first it appears absent (as in Staphylinidae) more careful study shows it is there, though subordinated to the many other folds. In one series, however, of which Anthrenus and the Lyctidae are fine examples, the apparent hinge is another fold, it works the other way, with the outer part

underlying the more basal, and is located before the end of the cell. On further examination we find that at the place where the pivot should exist, just beyond the cell, there is a single concave fold, followed by a single convex one, so that the costa as we follow it folds up and over, and then back again.

Just below the hinge, in the Adephaga, we can almost always see the oblong cell, but twisted around, and partly tucked under cubitus in a distinctive way; in the few cases where that cell is lost, there is still an area of the wing which is twisted around and tucked under cubitus in the same way though it only bears a single vein down the middle (e.g. Cicindela and Physodes). The Archostemata (Cupes and Micromalthus) alone share this feature, but can be instantly recognized by the outer part of the wing, which is rolled in a double spiral instead of the usual folding; while the Haliplidae and the old world genus Hygrobia (Pelobius) are folded as if such a spiral had been ironed flat.

As we follow the costal edge out beyond the hinge, we find in the Adephaga that the next fold is always up and over, while in the vast majority of Polyphaga it is down and under. As a rule this fold lies about half way between hinge and apex, but it has a tendency to migrate back towards the hinge, especially in much-folded types where there are further folds beyond it; and in a good many families, mostly now called clavicorns, it has gone so far back as to cut off the hinge from the costa entirely; in this case as we follow the costal edge out, instead of turning back sharply at the end of the cell, it immediately turns down and under. There is another series of families, roughly corresponding to the group sometimes called Haplogastra, but including the Lamellicorns, in which the outer folds of the inner edge of the wing have moved forward instead, so that the outer part of Cubitus is folded squarely across. This group are not so easy to pick out, without a fuller study of the folding.

In a few cases single families are instantly recognized by the folding alone; thus in the Hydrophilidae that outer costal fold runs at a 45° slant, so that the costal edge turns back at a right angle, instead of directly back in itself,- only the Georyssidae share this character. In the Nitidulidae and the single Ptiliid which has preserved a complete folding, the costal convex fold is followed always by two concaves in succession. The Clambidae have a system all their own, which does not fit any of the groups I have defined above. In some other cases the venation alone will define a group; thus the Lamellicornia are marked by a distinctive loop in the anal area, a thick hook-like radial recurrent and many minute Strahladern in the outer part of the wing.

In some other cases the folding patterns challenge our classification. Thus the Dermestidae have three totally different kinds; Dermestes agreeing both in venation and folding with Dascillus, while all the genera with an ocellus preserved have a group-resemblance to the Bostrychidae and Lyctidae, while one or two genera are more like the Byrrhidae; on the other hand Nosodendron has no likeness to its supposed relatives in the Byrrhidae, but would not be out of place near Anthrenus. The Dascillidae of the conventional system are a complete hodge-podge, having at least seven types of folding, most of which are also found elsewhere in our system; thus Dascillus itself is almost like Dermestes, Rhipicera and Sandalus, while Eucinetus, Cyphon and Artematopus are three very distinct types within the general pattern of the Bostrychidae and Anthrenus. Bidessus is more unlike the other Dytiscidae than even the Gyrinidae are, but on the other

hand is much like the Haliplidae, Sphaerius is superficially an unchallenged clavicorn, but its wing shows perfectly the oblong cell and twisted central area of the Adephaga, and Hydroscapha, always placed near the Staphylinidae, looks almost exactly like it.

Again the pattern of Catopochrota shows instantly the very distinctive type of the normal Cryptophagidae, and Gnostus, which has batted about our systems, evidently goes along with the Lyctidae and Ptinidae, but in other cases the evidence is weakened by close resemblance in a whole series of families; thus there is no wing-difference at all corresponding to the separation of Mordelloidea and Tenebrionoidea, as e.g. used in Leng's catalogue; but this is weakened by the fact that the Elateridae, Lampyridae and Erotylidae are also fundamentally of the same type.